

MOTION STIMULATION EFFECTS
VIEWED WITHIN AN
INTRAPERSONAL SYSTEM
OF ADAPTIVE LEVELS

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A k a d e m i s k a v h a n d l i n g

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The present dissertation is based on the following five papers, referred to in the text by the respective Roman numerals. The first four were published in A.L. Andersson, A. Nilsson, E. Ruuth & G.J.W. Smith (1972), Visual aftereffects and the individual as an adaptive system, Lund: Gleerup:

- I Nilsson, A. & Henriksson, N.G. The oculogyral illusion and its relation to the spiral aftereffect in repeated trials. Pp. 188-195.
- II Nilsson, A. & Tibbling, L. Personality correlates of smokers with differing consumption of cigarettes. Pp. 240-247.
- III Nilsson, A. Comparisons between oculogyral illusion, turning sensation and nystagmus within a process frame of reference. Pp. 265-272.
- IV Nilsson, A. The influence of acoustic stimulation on the process regulation of nystagmus and oculogyral illusion. Pp. 273-284.
- V Nilsson, A., Magnusson, P.Å. & Vasko, T. (1972). Reflexive versus perceptual regulation - an investigation of nystagmus, oculogyral illusion, motion-and-median-plane and rod-and-frame. Psychol. Res. Bull., Lund Univer., Sweden, 12, No. 13.

Developmental and functional aspects of the vestibular system

It is frequently maintained (e.g. Schilder, 1964; Guedry, 1971) that adequate stimulation of the infant's vestibular apparatus is necessary for normal development to continue.

This idea is upheld by the fact that the vestibular apparatus is characterized by close connections with other sensory systems, and that motion, in an ontogenetic perspective, is the first and most basic stimulation to which the small child reacts. Thus, Smith & Smith (1962) express the opinion that "motion and perception are inseparably related. The development of perception in the child is the development of motion, and the only valid understanding of perception at any level is in terms of movements that define it" (p. 7). Schilder (op.cit.) expresses the same view, stating that "motion is not something independent and separate from perception, but is of its very essence" (p. 8). Arieti (1969) sees the origin of the three-dimensional space perception not in the visual system but rather in the vestibular apparatus with its three semi-circular canals. The psychoanalyst Schilder again (op.cit.) emphasizes the close relationship between the vestibular apparatus and the emotional development of the child, a relationship which is treated by Guedry (op.cit.) from a learning theoretical point of view.

The general formulations referred to above have been subject to very little empirical verification. This does not mean that empirical studies of the vestibular system have been lacking. Rather, the basis for these studies has been almost exclusively medical-physiological (e.g. Bender, 1964).

The author believes that in the adult motion stimulation is regulated by mechanisms having a broad range of influence. Therefore, an attempt has been made here to link the regulation of vestibular responses to more general functional systems. The first two studies (I, II) were concerned with the appropriateness of a general perceptual-personality model based on aftereffect perception in analyzing the process involved in the development of the oculogyral illusion (OGI) over trials.



OGI occurs (cf. Graybiel & Hupp, 1946) after stimulation of the lateral semicircular canals of the labyrinth when a stationary light-spot in a dark room is perceived as moving in predictable directions. Two continuous movements can be distinguished; following a deceleration stimulus the first apparent movement (OGI_I) is in a direction opposite to that of the previous rotation, whereas the second one (OGI_{II}) is in an inverse direction with respect to OGI_I . In studies III-V the primary aim was to investigate perceptual regulation within a systemic-genetic perspective. The focus here was on the relationship between perceptual and reflexive regulation, the latter operationalized consistently in terms of the nystagmus reflex. This reflex, caused by vestibular or optokinetic stimulation, comprises a continuous sequence of eye movements. Vestibular stimulation generates first the primary nystagmus and thereafter the secondary nystagmus. A nystagmus beat consists of a peripherally released slow eye movement and a fast returning eye movement centrally released (McCabe, 1965; Tibbling, 1970).

Description of personality through aftereffect perception

Measurement of aftereffect perception provides information about the individual's investment in experiences or representations of his internal world. Such representations refer to phenomenal contents such as wishes, memories, fantasies, feelings, sensations and the like. Thus, representations of the internal world are distinguished from those of the external world, i.e. from those pertaining to experiences having immediate reference in the environment. A systematic description of the individual's modes of aftereffect perception has been provided by Andersson (1972). The experimental approach employed - an offshoot of experiments designed by Kragh & Smith (1970) for their "percept-genetic

analysis" - yields access to the process involved in the individual's development of an aftereffect over a series of repeated trials.

In all his studies of visual (figural and spiral) aftereffects, Andersson measures duration as the dependent variable. Three parameters are used to describe different aftereffect patterns: (1) iL, the level of initial duration, (2) R, the direction of change in aftereffect duration over trials, (3) fL, the level where change in direction can no longer be observed, aftereffect duration stabilizing here (concerning stabilization of the OGI, see Nilsson, 1970). A combination of the three parameters describes the individual's course of development over trials. In the present studies a sum score of iL and fL (cf. Andersson, Nilsson & Henriksson, 1972) in combination with the R score is employed. Median values or values close to the medians of iL + fL and of R constitute the cut-offs. Four combinations are thus possible: (a) (iL + fL) high, R high, referred to as "hypersensitive", (b) (iL + fL) high, R low - "desensitive", (c) (iL + fL) low, R high - "sensitive" and (d) (iL + fL) low, R low - "hyposensitive".

The hyposensitive pattern, for example, indicates a low investment in and a definite orientation away from internal world representations. Since it is assumed in the model that an inverse relationship exists between the individual's investment in internal and external world representations, we should expect the hyposensitive pattern to indicate a high investment in and orientation towards external world representations. Thus, the aftereffect measurement provides an indication of the individual's "dependence" on internal and external world factors. The patterns at the extremities of the model (hyposensitive and hypersensitive) imply a dependence upon one kind

of factor at the expense of the other, while the patterns in the middle (sensitive and desensitive) are associated with a certain autonomy vis à vis one's internal and external worlds, a position favourable for the mastery of both. Empirical studies (Andersson, 1967a, b, 1969; Andersson, Fries & Smith, 1972; Andersson, Nilsson & Henriksson, 1972) have supported the basic ideas of the model.

Study I includes a description and analysis of OGI as well as an investigation of relationships between the OGI and the spiral aftereffect (SAE). When the durations of the various OGI components (OGI_I , OGI_{II} and OGI_{I+II}) were correlated with the duration of SAE, the correlations for the parameters iL and fL of OGI_{I+II} were found to be somewhat higher than those of OGI_I and OGI_{II} . Comparing the correlation coefficients between OGI and SAE for iL with those for fL revealed the latter to be somewhat higher (correlation between OGI_{I+II} and SAE for fL yielded the highest coefficient, $r = 0.74$). Throughout, correlations were lowest for the R parameter. Despite the non-significant correlations between OGI and SAE for R, the results did indicate a close affinity between the two phenomena with respect to inter-individual variation.

Study II represents a direct application of the aftereffect model, where the various adaptive patterns, as defined by OGI, are related to the consumption level of tobacco in a group of cigarette smokers. As in other studies (IV, V; Nilsson & Henriksson, 1967; Nilsson, 1970), OGI_{I+II} represents the adaptive process in the OGI. The study also involves the serial color word test (CWT), which has previously shown a clear-cut relationship to aftereffect patterns (Andersson, 1967a; Nilsson & Henriksson, 1967; Andersson, Nilsson & Henriksson, 1972). On theoretical grounds it

was predicted that hyposensitive smokers are heavier consumers of cigarettes than other individuals. The results of both OGI experiment and CWT were in line with this hypothesis.

A systemic-genetical approach to perception

The adaptive action of an organism is always preceded by activity in the CNS described as alertness or attention (cf. Magoun, 1964) and induced by impulses from either external or internal sources. This "orienting reaction" (Sokolov, 1963) is more preparatory than consummatory and is pre-adaptive rather than adaptive in nature. Thus, the "reaction" (cf. III, IV) or "orienting system" functions as a system for activating the "action system". The tendency to initiate action when alerted should be regarded as a deep-seated characteristic of the organism.

The neonate can be considered as having an "orienting system" and an "action system". At an early stage a close relationship exists between the two, factors which differentiate them still being undeveloped at this early stage. Within the "action system" three subsystems can be distinguished: the "reflex action system", the "perceptual system" and the "conceptual system". The latter two, at this stage, are only in an embryonic form. The inborn reflexes (grasp reflex, sucking reflex, etc.) are connected with the "reflex action system" and constitute the infant's first and most primitive means of mastering or adapting to the environment. Through interaction with the environment the units or structures behind the reflex actions are developed, forming as Piaget (1953) has described, the basis for more complex and refined sensorimotor behaviors. It is suggested here that the energy resources of the "orienting system" are vital to a child for the successive shaping and establishing of the sensorimotor units, due to the close interconnection between the "orienting system" and "reflex ac-

tion system".

Quite early in ontogenesis the role of the "reflex action system" as the dominant means of adaptation diminishes. This occurs simultaneously with the development of both the "perceptual" and "conceptual" systems. These gradually take on their functions and permit successively higher-order forms of adaptation. Concomitant with the decrease in adaptive function of the "reflex action system" there is a general stagnation in its development and at this stage a definitive or stabilized form is reached, without any pronounced differentiation from the "orienting system" occurring.

In the adult individual the three "action systems" are hierarchically organized. The "reflex action system" is at the lowest and the "conceptual system" at the highest level within the hierarchy. The notion of hierarchy, however, has several implications, of which just three principal ones will be taken up here. The first bears upon the genetic aspect delineated above, and refers to the differing significance of the three "action systems" as adaptive tools during different developmental phases. The second relates to the remoteness of the external object: the "reflex action system" is dependent upon an immediate contact with the external object for its functioning. Immediate contact is not necessary for the "conceptual system" to function, since "all" aspects of the object are internalized, so that it can be remote, temporally and spatially. The third implication bears upon the mode of differentiation from the "orienting system": with increased hierarchical distinction comes a concomitant differentiation from the "orienting system", i.e. increasing degree of autonomy with respect to this system.

Within the delineated hierarchy of systems the "perceptual system" occupies an intermediate position. Viewed in the light of the three implications outlined above, the following characteristics of this system can be described: (a) During the developmental stage following the sensorimotor one, the child frequently evolves "perceptual solutions" for adapting to the environment. Piaget has called this the preoperational stage, but it might equally well be named the "perceptual period". (b) The boundaries for the child's contact with external objects are extended and enlarged within the "perceptual system" relative to those of the "reflex action system". Generally, the external object is coincident with the percept of it, but aftereffect perception may be regarded as an example of the "perceptual system" having reached a certain degree of freedom from the immediate presence of the external object in time. (c) The relationship of the "perceptual system" to the "orienting system" is characterized by a certain autonomy, a prerequisite to stability in experiencing of the external world. In summary, the intermediate position of the "perceptual system" within the suggested hierarchy makes it a unique system for exploring the individual's attempts to deal with the confrontation between impingements from the external world and the needs of the internal world.

Study III compares the OGI, the turning sensation and nystagmus in their course of development over trials, with the aim of delimiting the "perceptual system" from the "reflex action system". Nystagmus characteristics measured here are speed of the slow phase, amplitude and duration of primary nystagmus, as well as frequency of secondary nystagmus. Correlation coefficients between the OGI and nystagmus were low and insignificant throughout. Nystagmus also showed no significant correlations with turning sensation, despite the fact that the two are released by the same stimulus (chair acceleration) and

continue in a parallell manner initially. OGI consistently showed significant positive correlations with turning sensation. Besides there being qualitative differences between OGI and nystagmus, as well as between turning sensation and nystagmus, there were clear differences in the individual's regulation of their quantitative aspects. Thus, the results support the idea of a distinction between the individual's perceptual and reflex action regulatory systems.

The aim of study IV was to investigate whether a sudden change in the activation state of the "orienting system" influences reflexive and perceptual regulations in different ways. The basis of the study was their differing degrees of differentiation from the "orienting system", as assumed here. OGI and nystagmus measurements over trials operationalized the regulation within the two systems. A bell signal, aimed at producing change in the activation state, affected the amplitude and duration of nystagmus, while it did not affect the other characteristics and the OGI. Besides supporting the distinction between the perceptual and reflexive regulations, the results suggest that it is reasonable to divide the "reflex action system" into different subsystems. Furthermore, it was found that following the bell signal hyposensitive subjects, as defined by the OGI experiment, had a larger increase in amplitude than did other subjects. This result appears to reflect the hyposensitive individual's dependence upon stimulation with environmental connotation.

Study V was intended as a further analysis of the connection between the "perceptual" and the "reflex action" systems, utilizing a situation - "motion-and-median-plane" - where the two systems are simultaneously evoked. In "motion-and-median-plane" the deviation of the apparent median plan, occurring when the environment (an optokinetic drum) is rotating around the individual, is studied. Thus, the subject's task is to reproduce his image (internal world representation) of his median plane when concomitantly influenced by an immediate external world representation (the rotating drum). The magnitude of the median plane deviation gives an indication of the subject's dependence upon the immediate environment. The motion-and-median-plane experiment (MMPE) consists of ten continuously repeated measurements. Also the OGI experiment and a serial rod-and-frame test (RFT) were given. The use of the MMPE, actualizes the problem of the relationship between vestibular nystagmus (VN) and optokinetic nystagmus (OKN). The various characteristics of VN and OKN showed significant positive correlations between one another throughout. Another problem considered was that of perceptual and reflexive regulation in the MMPE. Initially (trials 1 and 2) deviation of the apparent median plane showed positive correlations with speed of the slow phase of OKN. During the continued course of development over trials perceptual regulation, as defined by both the OGI experiment and the RFT, was more and more decisive for the subject's median plane deviation. The results are consistent with the view of a genetic-hierarchical organization of regulatory mechanisms in adaptive processes.

Theoretical implications

As outlined above, inborn reflexes are decisive for the neonate's initial adaptation to the environment. The grasp reflex, for example, puts the child in touch with objects in the external world, the reflex activity itself mediating and leaving within the child

the first object representations (cf. Piaget, 1953). The unit or structure underlying such reflexes is characterized by a rhythmic form and always includes two antagonistic processes functioning mutually, one in the direction $A \rightarrow B$ and the other in the direction $B \rightarrow A$ (Piaget, 1947). Brown (1914) regarded this rhythmic phenomenon, and not the spinal reflex arc and its activity, to be the fundamental morphological and functional unit of the CNS. The operation of the two components within the inborn nystagmus reflex (Groen, 1965; Tibbling, 1969) exemplifies the rhythmic form of the unit underlying such reflexes. Similarly, just as the grasp reflex can be said to produce the first object representations, the nystagmus reflex can be said to provide the first representations of motion - whole body and whole world motion (cf. V) - within the child. Tibbling (op.cit.) has shown that in the small child the peripherally released slow phase is a sensitive tool for "reading off" motion. Thus, children younger than one year show maximal eye speed in the slow phase, much like the maximal speed of the vestibular (rotatory) stimulus. Older children (Tibbling op.cit.) and adults (Henriksson, 1955; Nilsson, 1970), on the other hand, show lower maximal eye speed than is present with the vestibular stimulus; the slow phase of nystagmus loses its capacity of the correct "reading off" or registering of motion quite early in the ontogenesis. This is to be associated with the decreasing significance of the "reflex action system" as an adaptive tool for the growing child. The centrally released fast phase, which is counteractive to the slow phase, should be considered as an immediate response of the organism to the registered motion. Thus, both the slow and fast phase activity are decisive for (quasi) definitive representation of motion stimulation to be established within the organism. Goldstein (1939), also viewing the "nystagmus-like" rhythm

as the basic "excitation course" of the CNS, emphasizes its significance for the "coming to terms of organism and world". The present author would support Goldstein's view and call attention to the way in which the two rhythmic components as in nystagmus make it possible for "two worlds", the internal and external, to be confronted with one another within the individual.

At a reflexive level, the temporal order of the two rhythmic components is quite clearly given, but at higher functional levels, where the two components are likewise found, their relationship appears more flexible. In perceptual regulation, therefore, both the components should be found. The processes which enable investment in internal and external world representations to occur (cf. p. 3) perform functions here similar to those of the rhythmical components at the reflexive level. In perception, just as in reflex action, the internal and external worlds encounter one another within the individual, an encounter preceding each (quasi) definitive percept. At the perceptual level, the stereotyped order of the two components at the reflexive level does not exist, a rigid rhythmic pattern being replaced by a more flexible one; the activities of the two components are relatively autonomous to each other over time. This view of perception makes it justifiable to regard the "perceptual system" as an "action system"; the subject's active contribution in the perceptual act is decisive for the (quasi) definitive configuration of the individual percept. Such a view is in line with that of Heinz Werner (1948), who emphasizes constructive activity in perception.

The original rhythmic activities may be thought to provide the basis for adaptive regulation even at the conceptual level. The determining principle at this level can be hinted at by the fol-

lowing question: How is it possible that a "subject" at a conceptual level can discover "facts" about, i.e. adapt to "facts" of, an "object" in the environment, "facts" previously unknown to him? Underlying such a conceptual act is not only the "reading off" of new aspects of the "completely" internalized object, but also the restructuring of an earlier (quasi) established pattern or structure with assimilated elements of this object, i.e. a structure (quasi) established at a lower, more "concrete" or "practical" functional level. What occurs within the individual is the "theoretical" treatment of a (quasi) structure which, while established at a practical level, has been restructured. Mutual operation of the two basic activities at this high functional level is thus characterized by enhanced elasticity. While there is not the intent here of delving into the details of the dually functioning principle at length, its continuous operation at differing functional levels within the individual can at least be hinted at.

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